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C-A OPERATIONS PROCEDURES MANUAL

15.3.2.1 Procedure for the Operations of the Booster Main Magnet Power Supply

(Booster/AGS Ring Power Supply Systems Group Procedure EPS-B-001)

Note: This document was formerly a C-A Group Procedure. The content of the group procedure was reviewed by the Technical Supervisor. All approvals and/or issue dates of the original group procedure are maintained for present use.

Hand Processed Changes

<u>HPC No.</u>	<u>Date</u>	<u>Page Nos.</u>	<u>Initials</u>
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Approved: Signature on File  
Collider-Accelerator Department Chairman      Date

M. Bannon

Booster/AGS Ring Power Supply Systems  
Group Procedure EPS-B-001  
Revision 00

### 15.3.2.1 Procedure for the Operations of the Booster Main Magnet Power Supply

I. BMMPS LOTO for Ring Entry	Check Each Step
1. Press the rectifier's <b>STANDBY</b> push button in RK #4965.	<input type="checkbox"/>
2. Turn the 95 Switches Station I & 95 Station II switches to open in RK #4965. This opens the two air operated 95 Switches opposite PS-ID and PS-IIA.	<input type="checkbox"/>
3. (Verify the 95 Switches have opened and grounded the magnets by looking through the inspection window.)	
4. Turn the key on the side of the 95 Switches which locks the 95 Switches in this position. Remove the keys on the side on 95 switch Station I & 95 switch Station II and bring them back to RK #4941. Insert them into Kirk lock Key. See labeled <b>THE RING ACCESS KEY TREE</b> .	<input type="checkbox"/>
5. MCR can now turn the MCR-1 Key and remove the key for MCR'S Ring Entry LOTO Procedure.	<input type="checkbox"/>
II. BMMPS Turn "ON" Procedure after Ring Entry	Check Each Step
1. Procedure for turning the BMMPS –"ON" after the Ring Entry is completed. (System LOTO removed)	
1. All Power Supply keys are in the <b>Power Supply Key Trees</b>	<input type="checkbox"/>
2. All 1B keys are in the <b>1B Key Tree</b> .	<input type="checkbox"/>
3. MCR-1 key and PSG-1A return to <b>Ring Access Key Tree</b> .	<input type="checkbox"/>
4. Turn the MCR-1 key to release the two keys for <b>95 Switches 95 Station I &amp; 95 Station II</b> .	<input type="checkbox"/>
5. Remove <b>95-I &amp; 95-II keys</b> and insert them into the side of the <b>95 Switches 95 Station I &amp; 95 Station II</b> . Turn keys to unlock the 95 Switches from the grounded position	<input type="checkbox"/>
6. In RK #4965 turn the control switches for both 95 Switches Station I & II . This will close the BMMPS disconnect switches 95-I & 95-II, and the red closed lights on the panel should come "ON".( This connects the BMMPS to the Booster Ring Magnets)	<input type="checkbox"/>
7. From the sun terminal bring up the BMMPS program. Load the live function. Check at the BNC RK #4962 the voltage references for PS-IAB, ICD,IEF, II-AB,II-CD, &II-EF AND current reference for PS-IAB. Compare them to the calculated voltages on the Sun terminal. ( These can be seen by selecting View from top menu bar then select any 4 references you want to be displayed on the monitor)	<input type="checkbox"/>
8. If the references all look like the ones that were calculated on the Sun terminal then the BMMPS can be turned "ON" from RK #4965.	<input type="checkbox"/>

9. From RK #4965 press the “ON” PB this will turn on the circuit breakers that have been configured on the Allen Bradley screen in the (Configure Section) sequentially taking approx. 15 sec to turn on all six circuit breakers. Then after all six circuit breakers are closed the reference to the power supplies will be released to the regulators and the power supplies should start pulsing. IN RK #4962 verify that V ref Vs V out for all six pair of power supplies look correct. If not call in a specialist.

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### III. Procedure/Checklist for LOTO of the Booster Main Ring Power Supply for Power Supply Access

### Check Each Step

Any time access to the BMMPS (Booster Main Magnet Power Supply) is required or any need to inspect or reset any interlock involving any of the BMMPS transformers, this Procedure/Checklist must be followed.

1. **LOTO the Vertical Tune Trim Quad** (located in Bldg. 930 UEB-BAF Power Panel CB#12) ☐

(Note: turn power supply to standby before LOTO is started)

2. **LOTO the Horizontal Tune Trim Quad** (located in Bldg 930 UEB-BAF Power Panel CB#11) ☐

(Note: turn power supply to standby before LOTO is started)

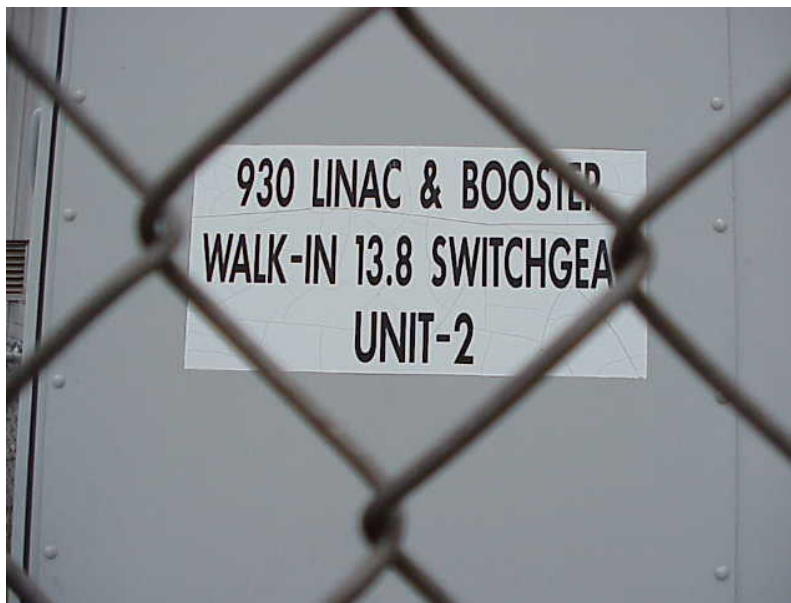
3. Set the BMMPS to “**STAND-BY**” by pressing the Stand-by push button located in RK #4965 below the Booster Alarm Monitor computer. ☐
4. Turn the BMMPS main 13.8 kv circuit breaker (**CB -1B**) “**OFF**” by pressing the CB-1B trip push button located in RK #4966 just left of the Booster Alarm Monitor. ☐
5. Turn the BMMPS main 13.8 kv circuit breaker (CB-1B) “**CONTROL POWER Key**” “**OFF**” which is located in RK #4966 on the same panel as the trip P.B. in step #4 and remove the CB-1B Control Power Key. ☐
6. Turn the control switches for the BMMPS “**95 Switches**” **Station I and Station II** to the “**OPEN**” position. This will cause both Green Indicator lights to come “ON.” These control switches are located in RK #4965 below the Booster Alarm Monitor Computer. ☐
7. Go to 95 switch Station I and verify that the switch is opened and the bus grounded by viewing the switch position through the inspection window noting that the switch is in a down position. ☐
8. Turn the Kirk key of the 95 switch Station I located underneath the viewing window and remove key. ☐
9. Go to 95 switch Station II and verify that the switch is opened and the bus grounded by viewing the switch position through the inspection window noting that the switch is in a down position ☐
10. Turn the Kirk key of the 95 switch Station II located underneath the viewing window and remove key. ☐
11. Insert both Station I and Station II 95 switch keys into the “**Ring Key Access Key Tree**” located in RK #4941 in console area. Turn the bottom key in this tree then remove the PSG-1A key. ☐

12. As of March 1, 2007 the arc flash was done on our 13.8kv switchgear and it was determined that it was now possible for our group to now rack in and out of the CB's wearing our Cat 4 blast suits and **we no longer needed the linecrew** to open switch K which is described below. So disregard the rest of step 12 and proceed to step 13. calculation As of Oct. 2006, until further notice we want the line crew to open the 13.8kvac 3 ph fused air switch located diagonally from our circuit breaker house next to Bldg 930 (**930 Linac & Booster Walk-In 13.8 Switchgear Unit – 2--Switch “K”**)



**Notes:**

- 1) The BMMPS (Booster Main Magnet Power Supply) must be off and all 7 of the 13.8kv BMMPS circuit breakers opened before the line crew opens Switch “K” in there switchgear.
- 2) Note, verify that all three phases are reading 13.8 kv inside the Booster MMPS CB House, and then after the line crew opens Switch “K” verify all 3 phases now read zero voltage. Install a lock and tag on Switch “K” until Booster work is completed.



13. Since the CB-1B Control Power Key is in your possession from step #5 and the ring is now grounded by following steps 6 thru 11 and we no longer need the line crew to open the fused air switch K in step #12, it is time to go outside to the Booster Circuit Breaker Enclosure Bldg. located inside the fenced area next to the fenced area of the Booster Transformer Yard. (**NOTE: It will be necessary to wear the proper clothing, blast suit (CAT 4-- 40 cal/cm2) and high voltage gloves in order to rack out this 13.8kv breaker.**) Once inside the Circuit Breaker Enclosure, go to **CB-1B's cell** and first verify CB-1B is in the “**OPEN**” position by looking at the flag on the CB that shows the status of the breaker (either says open or closed) Once it has been verified the CB-1B is open and the line voltage to CB-1B is zero, suit up properly in CAT 4 suit & rack out CB-1B to a “**TEST**” position by using the manual crank. After it is in a Racked Out to the Test Position, remove the #1 key. Lock the Breaker Enclosure Bldg and fenced area. Go back inside to RK #4941 and insert the #1 key and the PSG-1A key (from step #11) into the “**IB Access Key Tree**”



14. Turn the bottom 1B key of the “**1B Access Key Tree**”, this will release four (4) 1B keys and capture the #1 key and the PSG-1A key. The 1B key will open each gate in Bldg 930A. The 1B key also allows access into the Power Supplies. This is done by inserting one of the 1B keys into **Power Supply Key Tree** either Station I or Station II then turn the bottom key in the key exchange which will release all keys in that exchange. ( ex. 1B key into Station I Power Supply Key Tree will release PS-1A, PS-1B,PS-1C,PS-1D,PS-1E,&PS-1F Power Supply Keys) ☐
15. To return the BMMPS to a ready state (system LOTO removed) reverse steps 14 thru 1 as follows: ☐
  - a) All gates must be secured. ☐
  - b) Verify the DCCT electronic rack is powered. (light “on” on chassis) ☐
  - c) Power Supply keys returned to the **Power Supply Key Trees** ☐
  - d) All 1B keys returned to the **1B Key Tree**. ☐
  - e) MCR-1 key and PSG-1A return to **Ring Access Key Tree**. ☐
  - f) Remove 95-I & 95-II keys and insert them back into the 95 **Switches 95 Station I & 95 Station II turn keys to unlock switches**. ☐
  - g) In RK #4965 turn the control switches for both 95 Switches Station I & II. This will close the BMM disconnect switches 95-I & 95-II, and the red closed lights on the panel should come “ON”. ☐
  - h) Take the CB-1B key along with the console control power key for CB-1B outside to the Breaker Enclosure Bldg. Open the area using a UEB-19 key. Suit up wearing proper clothing as stated above then open the cell for CB-1B insert CB-1B key into Kirk lock and turn, then rack in CB-1B into cell ☐
  - i) Have the line crew open the area to Switch “K” and remove your lock and tag the have the line crew recluse Switch “K” and verify we have our 13.8kv line voltage back. ☐
  - j) Lock up Breaker Enclosure Bldg. & fenced area. ☐
  - k) Insert the console control power key for CB-1B back into the key lock in RK #4966. This has now brought the BMMPS out of a LOTO state. ☐
  - l) Remove the LOTO of the horizontal and vertical Quads. ☐
  - m) Ask MCR to resend the live functions to the Quads and then turn them “ON”. Press the “Stand-by” push button in RK #4965 this should bring the entire System to a ready state. This can be verified by bringing up the BMMPS program on the Sun terminal and load the live function. ☐
  - n) Check at the BNC RK #4962 the voltage references for PS-IAB, ICD, IEF, II-AB,II-CD, &II-EF AND current reference for PS-IAB. Compare them to the calculated voltages on the Sun terminal. (These can be seen by selecting. View from top menu bar then select any 4 references you want to be displayed on the monitor) ☐
  - o) If the references all look like the ones that were calculated on the Sun terminal then the BMMPS can be turned “ON” from RK #4965. ☐

#### IV. Booster Main Magnet Power Supply Instructions for Restarting BMMPS after fault

Check Each  
Step

1. If BMMPS trips during operations
  - a) Check if any Lock out Relay operated. ☐
  - b) Check if there are any Transformer interlock messages on PLC Monitor. ☐
  - c) If the trip is not due to a) or b) the BMMPS can be reenergized two Consecutive times before calling the System Specialist. ☐
2. If the trip is due to 1a) or 1b):

<b>DO NOT RECLOSE CIRCUIT BREAKERS</b>
--

3. Check and record in BMMPS log book the following information:
  - a) If any Lock Out Relay operated: (RK #4966) ☐
    - i) Overcurrent relay flags include phase (or ground) and relay type (Overcurrent instantaneous) (RK #4967 & RK #4968)
  - b) If there are any Transformer interlock messages on PLC Monitor ☐
    - i) Record PLC message
    - ii) Outside ambient temperature and weather conditions
    - iii) Transformer tank pressure, temperature, and regulator pressure.
  - c) Additionally, for either a) or b) above, record in Log book: ☐
    - i) Time and date
    - ii) Operating conditions prior to trip

<b>4. Call system specialist and advise of trip and data collected above.</b>
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5. When system is to be returned to service: ☐
  - a) Verify that all relay flags have been recorded. ☐
  - b) Reset all relay flags. ☐
  - c) Verify that pressure switch position has been recorded. ☐
  - d) Verify that there are not transformer interlock messages on PLC Monitor. ☐
6. To recluse CB:

<b>a) If pressure switch has to be reset, follow LOTO procedure for Main CB 1B before resetting switch.</b>
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- b) Remove LOTO. ☐
  - c) Re-close CB 1B. ☐
  - d) Check all BMMPS reference functions ☐
  - e) Close all other CB's. ☐
  - f) Verify that all flags and messages are clear before leaving area. ☐
7. Repeat procedure if a CB trips again. ☐

Read and understood by: \_\_\_\_\_  
Print Name

Life No. \_\_\_\_\_

Date: \_\_\_\_\_

## V. BMMPS DC Bus Link Change Checklist

**NOTE:** Each pair of rectifier modules of the BMMPS (6 each) can be isolated from the Main DC Output Bus. Rectifier modules shall be isolated as pairs only. When the rectifier module pairs are isolated, entry into the modules is permitted for servicing or testing independent of the rest of the modules. Only access to the side doors in front of the fence area is permitted when rectifier module is isolated. (SCR Area Left Bank and Right Bank.)

**Check Each  
Step**

### RECTIFIER LINK CHANGE CHECKLIST

1. In RK #4965 press the **ST-BY** P.B. ☐
2. In RK #4965, **Open** the 95 Switches for Station I & II, remove the keys from the side of the 95 Station I & II Switches and bring them back to the ring access key tree and insert into the tree. ☐
3. Turn and remove the PSG-1A Key from the Ring Access Key Tree and insert the PSG-1A key into the 1B Access Key Tree. ☐
4. In RK #4966, press the **OFF** PB for CB-1B and turn the control power key to the off position then remove the key. ☐
5. Have the line crew open the 13.8KV Switch "K" which feeds the line side to our CB-1B in our breaker enclosure building. ☐
6. Go outside to the breaker enclosure building using a UEB-19 Key to enter verify there is no line voltage present by reading the meter on the front door of the PT Cubicle. Then properly suit up, wearing **CAT. 4-- PPE**. Rack out CB-1B. Note: First make sure CB-1B is open by visually looking at the window on the CB that should show status – OPEN. ☐
7. LOTO CB-1B in a test position and remove the 1 Key from Kirk lock in CB-1B Cubicle. ☐
8. Rack out the circuit breakers of each rectifier module pair that requires there DC Bus Links changed.
 

CB-2A	PS- IA & IB	<input type="checkbox"/>
CB-3A	PS- IC & ID	<input type="checkbox"/>
CB-4A	PS- IE & IF	<input type="checkbox"/>
CB-2B	PS-IIA & IIB	<input type="checkbox"/>
CB-3B	PS-IIC & IID	<input type="checkbox"/>
CB-4B	PS-IIE & IIF	<input type="checkbox"/>
9. LOTO the CB from step number 7 who's links need to be changed and remove there keys from the CB cubicles. ☐
10. Insert the keys from step 8, (Keys #2 thru #7) into the appropriate key tree located within the circuit breaker house on the north wall. Turn key which will release two keys from each tree involved in link change ☐

(Note: There are six - 3 key trees on the north wall of CB House, one for each CB which will release 2 keys, one for each PS that the CB powers.) (e.g., key #2 will release two - 2A keys – 1 for PS-IA and 1 for PS-IB.)

11. Bring all keys that have been released from steps 6 & 9 back inside building 930A. ☐
12. Turn the bottom 1B key of the 1B Access Key tree, this will release four (4) 1B keys and capture the #1 key and the PSG-1A key into the 1B Access Key Tree. ☐
13. The 1B keys will be needed to gain access to the gated areas. ☐
14. Insert the circuit breaker lockout keys (Ex. 2A, 3A 4A, 2B, 3B, 4B) in to the POSITIVE DC bus link assembly of the first module of the rectifier pair and unlock the bus link. ☐

(Note: Two rectifier modules make up one power supply; this is the reason for the two circuit breaker lockout keys as stated in step #9 example. This procedure must be completed in both rectifier modules of each pair, a fault will be detected by the interlock monitor system (PLC) if both rectifier modules are not changed correctly.)

15. Loosen the two bolts on the bus link and remove the lower bolt, the upper bolt is captive and move the bus link to the other position insert the lower bolt and retighten bolt bolts. ☐
16. Remove the released key of the positive dc bus link and insert it in the lock of the new position and lock the bus into the new position. Remove the released key of the locked bus and secure the power supply door. ☐
17. Take the released key from step 15 and insert it into the negative bus link lock and unlock the negative bus link lock. ☐
18. Loosen the two bolts on the bus link and remove the lower bolt, the upper bolt is captive and move the bus link to the other position. insert the lower bolt and retighten both bolts. ☐
19. Remove the released key of the negative dc bus link and insert it in the lock of the new position and lock the bus into this new position. Remove the released key of the locked bus then lock and secure power supply door ☐
20. The released key of the negative dc bus link lock from step #18 may now be inserted into one of the two side door locks of the rectifier module. Access to this rectifier module is now permitted when system is running ☐
21. Repeat steps 13 thru 19 on the other rectifier module that is paired with the rectifier module that was just done in steps 13-19. (ex. steps 13 –19 were done to PS-IC now repeat those steps for PS-ID ☐
22. Repeat steps 13 thru 20 for each additional rectifier module pairs that require the dc bus link positions changed ☐
23. If access into the power supply is not required then the released keys of the negative db bus links shall be stored in the key lock box located inside the rear door of RK #4965 ☐
24. On the Allen Bradley Screen choose the CB “Configure” Menu and de-activate the CB’S which will not be used since power supplies have now been bused out note: this is menu driven and the screen tells the operator how to activate and deactivate a circuit breaker.) ☐

25. Make a note of what power supplies the links have been moved?

☐

What circuit breakers are racked out?

And what CB has been deactivated?

### POWER SUPPLIES

PS-IA	<input type="checkbox"/>	By: _____	Date: _____
PS-IB	<input type="checkbox"/>	By: _____	Date: _____
PS-IC	<input type="checkbox"/>	By: _____	Date: _____
PS-ID	<input type="checkbox"/>	By: _____	Date: _____
PS-IE	<input type="checkbox"/>	By: _____	Date: _____
PS-IF	<input type="checkbox"/>	By: _____	Date: _____
PS-IIA	<input type="checkbox"/>	By: _____	Date: _____
PS-IIB	<input type="checkbox"/>	By: _____	Date: _____
PS-IIC	<input type="checkbox"/>	By: _____	Date: _____
PS-IID	<input type="checkbox"/>	By: _____	Date: _____
PS-IIE	<input type="checkbox"/>	By: _____	Date: _____
PS-IIF	<input type="checkbox"/>	By: _____	Date: _____

### CIRCUIT BREAKERS

2A	<input type="checkbox"/>	By: _____	Date: _____
3A	<input type="checkbox"/>	By: _____	Date: _____
4A	<input type="checkbox"/>	By: _____	Date: _____
2B	<input type="checkbox"/>	By: _____	Date: _____
3B	<input type="checkbox"/>	By: _____	Date: _____
4B	<input type="checkbox"/>	By: _____	Date: _____

### CIRCUIT BREAKERS DEACTIVATED ON ALLEN-BRADLEY SCREEN

2A	<input type="checkbox"/>	By: _____	Date: _____
3A	<input type="checkbox"/>	By: _____	Date: _____
4A	<input type="checkbox"/>	By: _____	Date: _____
2B	<input type="checkbox"/>	By: _____	Date: _____
3B	<input type="checkbox"/>	By: _____	Date: _____
4B	<input type="checkbox"/>	By: _____	Date: _____